

## **AN ALTERNATIVE VIEW OF THE COURSE OF EVOLUTION WITH IMPLICATIONS FOR LIFE ELSEWHERE IN THE UNIVERSE**

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The conventional view of evolution is that life originated in the sea and evolved minimally for the next several billion years until the atmosphere oxygenated enough to allow metazoan respiration. Land plants subsequently became established, and organisms crawled out of the sea to eat them. Evolution of life in both marine and non-marine environments followed. However, consideration of the probable temperature and salinity history of the Earth's hydrosphere suggests a different possible scenario.

Oxygen isotope data indicate that Archean temperatures were like hot tap water, so early thermophilic microbes could have been global and not just huddled around hydrothermal vents. The initial high salinity of the Earth's ocean persisted throughout the Archean in the absence of long-lived cratons required to sequester salt and brine accumulations derived from evaporating seawater. Because  $O_2$  solubility decreases strongly with increasing temperature and salinity, the Archean ocean was anoxic even if atmospheric  $O_2$  were high. Marine life was limited to anaerobic microbes that could tolerate hot, saline water. Temperatures declined dramatically in the Paleoproterozoic. Values similar to those of the Phanerozoic were reached by 1.2 Ga. Microbial evolution continued at a slow pace in the still salty, largely anoxic sea.

The first major lowering of oceanic salinity probably occurred after deposition of the great Neoproterozoic salt deposits. This salinity decrease together with major cooling associated with the Neoproterozoic glaciations allowed significant dissolved  $O_2$  in the ocean for the first time. This terminated a vast habitat for anaerobes and produced threshold levels of oxygen required for metazoan respiration in the sea. Fresh water environments could hold  $O_2$  and thus oxygenated much earlier than did the ocean. The possibility arises that Precambrian soft-bodied metazoans developed in these non-marine environments first and then moved into the sea following the great salinity decline. These salt-stressed metazoan pioneers would have encountered a medium saturated with respect to carbonate, opal, and phosphate. Shells and hard parts of calcite, opal, and apatite across the phyla could thus easily form.

Non-marine deposits are highly susceptible to erosion and thus have very low preservation potential. Precambrian examples are rare, but they do have stromatolites and microfossils. The non-marine appears to have been an active site of early evolution. The search for evidence of metazoans in the localized and rarely preserved non-marine Neoproterozoic environments is underway.

Cl is a common element throughout the galaxy and follows the water during atmospheric outgassing. It is therefore likely that early hydrospheres everywhere are highly saline. If salinity inhibited metazoan evolution on Earth for up to 3 Ga, then life elsewhere is either largely microbial or extraterrestrials are salty troops unlike anything we have envisioned.